

Transportation Management Toolbox Strategies

Introduction

This transportation management toolbox is being developed to provide the Kansas Department of Transportation (KDOT), Mid-America Regional Council (MARC), the Lawrence-Douglas County Metropolitan Planning Organization (MPO) and local governments, a systematic approach to identify potential transportation strategies that address corridor transportation needs. This initial report describes a list of potential transportation strategies that will be considered in the toolbox.

5-County Regional Transportation Study Phase 1

The Phase I report of the 5-County Regional Transportation Study outlined the following conclusions:

- Traffic generation is anticipated to increase as a number of large land development projects are underway or are planned that will significantly impact the transportation system;
- Billions of dollars in transportation needs have previously been identified;
- Even more transportation needs will be identified as traffic impacts of many of the planned new large developments are determined;
- Funding for transportation needs is not anticipated to increase significantly.

The Phase I report organized a general approach to evaluating the potential impacts of transportation investments to consider how each project not only improved travel mobility but also affected the economy, environment and society—the triple bottom line.

The consensus from the Phase I study was that:

1. Transportation funds will not be available to address many of the corridor needs through a road construction program alone.
2. Solely focusing on mobility without considering economic, environmental or societal impacts could lead to inefficient transportation investment choices.

The 5-County Study is focused on the portion of the transportation system that includes the major interstates, US highways, state routes and major arterial routes that are under the jurisdiction of local communities. It also includes the four transit systems – Lawrence Transit, KU on Wheels, Unified Government Transit (including contracted service with the Kansas City Area Transportation Authority), and Johnson County Transit. Associated with these systems are supportive sidewalk and trail facilities and efforts to coordinate land use/development projects as they relate to the transportation system.

The strategies to address transportation needs have been grouped to address:

- Enhanced Management of the Transportation System
- Reduced Travel Demand
- Increased Transportation System Capacity

Congestion Management Plan Process

The approach to managing the transportation system including efforts to reduce transportation demand was initiated in a large scale following the energy price increases and economic downturn experienced in the late 1970s and early 1980s. In the 1990s, federal transportation legislation required larger Metropolitan Planning Organizations (MPOs) to develop Congestion Management Plans (CMP). An overall objective of CMPs has been to maximize the efficiency of existing transportation systems and facilities *before* considering strategies that increase capacity. This 5-County planning process follows the general CMP approach and includes defining congestion management objectives, developing performance measures, and identifying and evaluating strategies.

While the transportation system serving the 5-County region is auto-oriented, recent experience with energy price increases reinforced the need for alternative transportation modes such as carpooling, public transit, bicycling, and walking to offset higher energy prices.

Strategy Description

The transportation toolbox strategies are described in the following sections. The desired outcomes developed in the first phase of the 5-County Study serve as the objectives in which the transportation strategies are compared. These objectives are defined below:

- **Scale:** A specific strategy can be applied at the intersection or point level, along a corridor, or area-wide.
- **Desired Outcomes:** While each desired outcome can include consideration of a number of evaluation criteria, the evaluation of strategies as described here focuses on a simplified number of criteria or factors related to the general evaluation of the overall strategy as discussed below:

- **Choice:** Degree in which strategy provides for choice of auto and non-auto modes of transportation or provides information on choice of travel route or time of travel.
- **Mobility:** Degree in which strategy supports the movement of vehicles and goods and improves travel time and reduces delay.
- **Safety:** Degree in which strategy would lead to reduced crash rates.
- **Public Health:** Degree in which strategies support healthy lifestyle by providing opportunities for exercise as part of travel.
- **Efficient Use of Financial Resources:** This represents general level of anticipated cost.
- **Environment:** For this evaluation, this outcome is reflected in the anticipated impact to reduce Vehicle Miles Traveled (VMT) or vehicle emissions.
- **Regional Prosperity:** The degree in which the strategy would have economic impacts.
- **Social Equity:** Degree in which the strategy provides for travel opportunities to persons without access or unable to use a private vehicle.
- **Livability:** Degree in which the strategy would be consistent with a development scale that enables mixed land use and would not create barriers across a community.
- **Ease of Implementation:** This includes political considerations, public perception, reaction of transportation system managers, or environmental considerations.

The following is a summary of the types of transportation strategies that can be considered. A more detailed discussion of these strategies follows.

Table 1. Definition of Strategies

Category/Strategy	Definition
System Management	This set of strategies emphasizes the management and operation of existing transportation facilities.
Traffic Signal Timing/Optimization	Upgrading traffic signal equipment and timings.
Freeway & Arterial Bottleneck Removal	Minor roadway geometric or traffic control improvements.
Ramp Metering	Traffic signals on ramps control vehicles entering freeways.
Access Management	Careful planning of access points along roadways.
Variable Speed Limits	Speed limits are changed based upon traffic conditions.

Category/Strategy	Definition
System Management	This set of strategies emphasizes the management and operation of existing transportation facilities.
Congestion Pricing	Variable toll pricing based upon peak or off-peak periods.
ITS Technology	ITS applications that address travel mobility.
Traffic Incident Management	Planned process to detect and respond to traffic incidents.
Travel Information	Provides information to drivers regarding traffic conditions.
Parking Management	Providing information regarding parking.
Travel Demand	This set of strategies address transportation needs by reducing the number of trips during peak periods.
Ridesharing	Includes both carpooling and vanpooling.
Public Transportation	Includes fixed route bus service and paratransit service.
Bicycle and Pedestrian Travel	Bicycle and pedestrian facilities.
Alternate Work Hours	Varying work schedules to avoid peak travel times.
Telework	Promoting telework to reduce the number of commuters.
Land Use Management	Guide development to lessen traffic impacts.
Increasing Capacity	This set of strategies refers to traditional capacity improvements such as adding lanes or new roadways.
Add Travel Lanes	Widening existing roadways to add travel lanes.
Modify or Add Interchange	Adding capacity to existing interchanges or adding new interchanges to system.
Construct New Highways or Arterials	Constructing new roadways on new alignments.
Intersection Capacity Improvements	Includes adding turn lanes, and roundabouts.
Transit Capacity	Includes added transit service and facilities such as ,park & ride lots,
HOV and Managed Lanes	A set of lanes where operational strategies respond to changing conditions. Includes high occupancy vehicle lanes.
Bicycle and Pedestrian Facilities	Construct bicycle and pedestrian facilities.
Freight Rail Track Improvements	Track related projects or grade separations.

Applying the Toolbox

The transportation toolbox presents a range of transportation strategies that can potentially address transportation issues within a corridor or an area within the 5-County region. This

approach provides organization to determining which strategies could be used. The following steps are suggested:

1. Identify the Desired Outcomes most pertinent to area, corridor or point being considered.
2. Examine Toolbox strategies, using the hierarchy of management, demand reduction, and then capacity.
3. Within this hierarchy identify strategies that best respond to each outcome for each transportation corridor.
4. Evaluate the selected strategies using the travel demand model, highway capacity model, simulation model or manual techniques as appropriate.
5. Following implementation, review the effectiveness of the strategies in meeting the toolbox criteria.

Toolbox Box Strategies

The transportation toolbox strategies are described in the following sections. *Table 2* lists those strategies that would be considered to best address each desired outcome. While the impact of a given strategy will vary given the characteristics of the area where it is applied, this table provides a starting point to discuss how a set of transportation strategies can be applied to address this range of desired outcomes. A full comparison of strategies related to desired outcomes is provided in *Appendix A*.

Table 2. Strategies Considered Most Effective by Desired Outcomes

Choice	Mobility	Safety	Regional Prosperity	Financial Resources	Environment	Public Health	Social Equity	Livability
Ridesharing	Bottleneck Remove	Signal Timing	Add Travel Lanes	Signal Timing	Signal Timing	Bicycle/ Ped	Public Trans	Land Use Management
Public Trans	Congestion Pricing	Bottleneck Remove	Modify/Add Interchanges	Bottleneck Remove	Bottleneck Remove	Bike Ped Facilities	Ridesharing	Bicycle/ Ped
Bicycle/ Ped	Access Management	Ramp Metering	Freight Rail	Ramp Metering	Ramp Metering	Land Use Management		
Transit Capacity	Ramp Metering	Access Management	Access Management	Access Management	Intersection Capacity		*others will vary by location of projects	* other projects can include livability elements
HOV Lanes	Add Travel Lanes	Variable Speed Limits	Intersection Capacity	Variable Speed Limits	Public Trans			
Managed Ln	Modify/Add Interchanges		Transit Capacity	Ridesharing	Bicycle/ Ped			
Bike Ped Facilities	Intersection Capacity			Telework	Transit Capacity			
Freight Rail	Transit Capacity	* other projects may have safety benefits if addresses design criteria		Parking Management	Bike Ped Facilities			
	HOV Lanes			Land Use Management				
	Managed Ln			Alternative Work Hours				
				*Projects with operations or higher capital costs vary by project				

A. System Management

These types of strategies seek to eliminate traffic bottlenecks and improve travel conditions by enhancing system capacity and improving reliability and safety. This set of toolbox strategies emphasizes the management and operation of existing transportation facilities. Transportation management strategies are typically low cost when compared with capacity projects. The objective of these strategies is to provide for improved traffic and transit operation often reflected by moderate improvements in travel mobility and reduced vehicle emissions. These strategies are applicable to both highway and transit operations. Many of the management strategies contribute indirectly to public health, regional prosperity, social equity and livability; however this contribution in this rating process is typically shown as “low”. These strategies typically do not have a major impact on increasing transportation modal choices.

Traffic Signal Timing/Optimization

Upgrading traffic signal equipment and implementing more efficient traffic signal timing and communication are ways to improve traffic movement along travel corridors. Traffic signal timing provides an opportunity to reduce vehicle delay on arterial streets by up to 15 percent with as much as 30 percent during peak hours¹.

The effort to provide more efficient signal timing is currently underway in the Kansas City area. The most prominent effort is Operation Green Light, a cooperative effort among more than 20 local governments to improve the coordination of traffic signals on major routes throughout the Kansas City area. In addition some communities also operate separate arterial traffic management centers that are integrated with Operation Green Light and extend similar benefits to the arterial network.

By improving travel times, signal coordination projects have been shown to provide travel mobility and safety benefits. The projects are considered to provide an efficient use of resources with modest costs related to signal hardware upgrades and construction of communications centers. Signal timing projects achieve environmental goals by reducing vehicle emissions but because of the travel time savings, the projects can lead to increased travel and a possible increase in vehicle miles traveled (VMT) which can negate some of the environmental benefits. Signal timing projects have less of an impact on other desired outcomes such as public health, social equity and livability.

Freeway and Arterial Bottleneck Removal

The freeway system and major arterial routes in the 5-County Region are rated as good condition and have been constructed or re-constructed to meet current design standards.

¹ FHWA, Olsson Associates

However, in certain locations, there could be opportunities to address traffic congestion through bottleneck removal. This strategy consists of identifying congested locations and improving elements including:

- Insufficient acceleration/deceleration lanes and ramps
- Improving weaving sections
- Addressing narrow lanes and shoulders
- Providing adequate signage and pavement striping
- Addressing other geometric deficiencies that may exist

This is a location specific strategy targeted to users of the street and highway system. In some cases where congestion occurs due to a few constrained locations, bottleneck removal can provide benefits to travel mobility. If the project addresses upgrading a design standard, it provides safety benefits. Compared to larger capacity projects, these projects can provide a very efficient use of financial resources by providing benefits with modest costs. Bottleneck removal projects which address vehicle delay will provide environmental benefits by reducing vehicle emissions, however it does not typically result in longer term sustainable environmental improvement by reducing vehicle miles traveled (VMT). Like most traffic management strategies, bottleneck removal will have less of an impact on other desired outcomes such as public health, social equity and livability.

Ramp Metering

Ramp metering is the use of traffic signals on a ramp to control the rate at which vehicles enter a freeway facility. By controlling the rate at which vehicles are allowed to enter a freeway, the flow of traffic onto the freeway facility becomes more consistent, smoothing the flow of traffic on the mainline and allowing more efficient use of existing freeway capacity. It can also encourage an increased use of surface arterials for shorter length trips. Ramp metering can be an effective tool to address congestion and safety concerns that occur at a specific point or along a section of freeway. It is being used on a small section of I-435 east of Metcalf Avenue to manage a difficult weaving section.

By regulating the entry of vehicles on to the freeway, ramp metering has been shown to improve vehicle mobility by increasing average freeway throughput and travel speed and decreasing travel delay on freeway mainlines. This is a point or corridor specific strategy targeted to users of the street and highway system. This project strategy can be considered to efficiently use resources due to travel benefits with modest costs. Ramp metering can provide environmental benefits through reduced travel delay leading to reduce vehicle emissions. This strategy typically has a small impact on improved travel safety, public health, social equity and livability. In some locations where ramp metering has been installed, it has led to concerns related to public acceptance.

Access Management

Access Management is a process used to maintain the mobility function of arterial routes by limiting vehicular access points between land parcels and roadways. This practice is already in use. KDOT has developed a Corridor Management Program that partners with local governments to develop transportation plans along highways experiencing growth and development. Access management can include increasing the distance of intersection spacing of both driveways and streets, providing turn lanes, providing medians and right-of-way preservation for future streets.

Access management supports the mobility function of a roadway and improves vehicle safety. Studies have shown that access management also leads to economic benefit over a period of time. While these actions do not typically require an environmental study, they do typically require completion of a corridor study including extensive coordination with businesses located on the corridor. Access management can support regional prosperity, but is not considered to have much impact on public health, social equity and livability.

Variable Speed Limits

Variable speed limits moderate freeway traffic flow in response to traffic congestion, weather, and construction. Variable speed limits can be advisory or regulatory. The speed limit is varied based on downstream conditions that drivers are heading towards, not necessarily conditions at the site where speed limits are changed. A moderated traffic flow can result in higher highway vehicle capacity and safety. When congestion (either recurring or due to traffic incidents) is detected, a traffic management center modifies speed limits upstream of the congestion so vehicles have slowed down prior to reaching congested areas. This speed reduction lowers the number of additional traffic incidents once the congested area is reached and harmonizes the speed and traffic flow over a larger segment of the highway. Speed limit variations across the entire facility smooth the flow of traffic which may prevent further congestion. The process results in traffic traveling through congestion-prone areas more quickly.

The Missouri Department of Transportation (MoDOT) uses variable advisory speeds along I-270/I-255 in St. Louis. When congestion starts building along stretches of I-270, MoDOT activates changeable speed signs to vary the advisory speed on the road. Variable Advisory Speeds along I-270/I-255 could range from 60 mph during extremely light traffic, to as low as 10 mph during extreme congestion. If the advisory speed posted is less than 60 mph, the speed will flash continuously. An earlier version of the program limited the minimum variable speed 40 mph.



Figure 1. Advisory Speed Limit Sign

Source: Missouri Dept. of Transportation

Variable speed limits can improve travel mobility in congested freeway locations by increasing average throughput and decreasing travel delay. It also can improve travel safety. The strategy requires coordination with existing ITS infrastructure and the costs of advisory speed signs. By reducing travel delay, variable speed projects will reduce vehicle emissions. This strategy is oriented toward highways, and as such will not impact travel choices. This is a new strategy that has not been widely used and as such may be initially difficult for motorists to understand and could have concerns related to public acceptance. This strategy can be very efficient with financial resources, in that project costs are relatively small. Like most traffic management strategies, bottleneck removal will have less of an impact on other desired outcomes such as public health, social equity and livability.

Congestion Pricing

Congestion pricing implements variable price tolling between peak and off-peak times in toll areas on bridge and roadway facilities, tollways, zones, or High Occupancy Tollways (HOT) lanes. The price differences induce drivers of less critical or more discretionary trips to shift their highway travel to off-peak periods or other modes.

Congestion pricing has different pricing strategies:

- Variably priced lanes have variable tolls on separated express toll lanes or high-occupancy toll (HOT) lanes within a highway.
- Variable tolls on entire roadways, which would place variable tolls on both toll roads and bridges, and on existing toll-free roadways and bridges during rush hour.
- Zone-based charges would charge a fixed or variable toll to drive within or into a congested area, such as a central business district.
- Area-wide or system-wide charges would utilize per-mile charges on all facilities with an area or roadway network that may vary by level of congestion.

At its fullest extent, congestion pricing would entail setting fees at a rate sufficient to maintain free flow traffic speeds within the toll area. Toll amounts can be predetermined according to a schedule or can be dynamically changed based on real-time congestion levels. Fees are typically collected electronically through the use of vehicle transponders or license plate identification technology. Congestion pricing in the U.S. is more common on High Occupancy Vehicle (HOV) converted to High Occupancy Toll (HOT) lanes.

Multiple locations throughout the U.S. and abroad have implemented versions of congestion pricing. Minnesota DOT is using congestion pricing on converted HOV lanes and Priced Dynamic Shoulder Lanes (PDSL) on I-35W into downtown Minneapolis. San Diego's I-15 has fees varied in 25-cent increments as often as every six minutes with the intent to maintain HOV

lanes free-flow traffic conditions. Approximately half of the revenue is used to support corridor transit service. Colorado DOT implemented congestion pricing in Denver on I-25 HOT lanes between downtown Denver and US 36. Drivers pay different rates based on the time of day use. Carpools and hybrid cars are exempt from the tolls on the I-25 HOT lane.



A yellow rectangular sign titled "Chicago Skyway Vehicle Tolls" listing toll rates for different vehicle types during two time periods: 4am-8pm and 8pm-4am.

Vehicles with	4am-8pm	8pm-4am
2 Axles	\$2.50	\$2.50
3 Axles	\$5.10	\$3.60
4 Axles	\$6.80	\$4.80
5 Axles	\$8.40	\$6.00
6 Axles	\$10.10	\$7.20
7 Axles +	\$11.80	\$8.40

Figure 2. Example of Congestion Pricing in Chicago

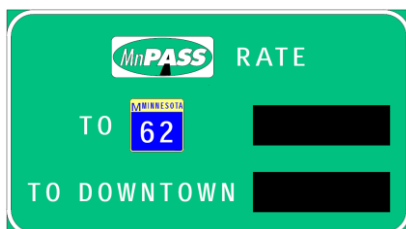


Figure 3. Example of Variable Pricing (Minneapolis)

Source: Minnesota Dept. of Transportation¹



Figure 4. Example of Express Lane Sign (Minneapolis)

Source: Minnesota Dept. of Transportation

Congestion pricing can have a moderate impact on reducing traffic congestion, increasing travel speed and reducing or spreading VMT. Congestion pricing has been shown to significantly spread weekday peak-period traffic to the hours just before or after peak toll rates are in effect for both cars and trucks². This can also contribute to lower vehicle emissions. Congestion

² Ozbay, K., Yanmaz-Tuzel, O., Holquin-Veras, J. 2006. *The Impacts of Time-of-day Pricing Initiative on NY/NJ Port Authority Facilities Car and Truck Movements*. TRB 2006 Annual Meeting. Accessed at <http://www.trb-pricing.org/docs/06-2548.pdf> . 4/21/2011.

pricing may not have a major impact on travel safety. This strategy would not have a major impact in the 5-County region given that most highways and roadways do not have tolls.

The cost of this strategy would be high to develop toll facilities on major routes. Another approach being tested by the Federal Highway Department involves the use of GPS devices in individual vehicles to record vehicle movement and to assess a VMT charge. These charges could be adjusted for peak and off-peak travel. A considerable amount of research and development will need to be completed in order to make congestion pricing a strategy that can be used in the 5-County area or most urban areas. The practical and political factors make this strategy difficult to implement on existing non-tolled highways. Like most traffic management strategies, bottleneck removal will have less of an impact on other desired outcomes such as public health, social equity and livability.

Intelligent Transportation System Arterial and Freeway Applications

Intelligent Transportation System (ITS) focuses on intelligent vehicles, intelligent infrastructure and the creation of an intelligent transportation system. ITS encompasses many areas of transportation and are part of many of the strategies included in this toolbox. This strategy includes those ITS actions that address travel mobility on freeway routes and the supportive arterial street network.

The types of ITS activities that support freeway and arterial operations include:

- Traffic surveillance systems use detectors and video equipment to support the most advanced freeway management applications.
- Traffic control measures on freeway entrance ramps, such as ramp meters, can use sensor data to optimize freeway travel speeds and ramp meter wait times.
- Lane management applications can address the effective capacity of freeways and promote the use of high-occupancy commute modes.
- Special event transportation management systems can help control the impact of congestion at stadiums or convention centers. In areas with frequent events, large changeable destination signs or other lane control equipment can be installed. In areas with occasional or one-time events, portable equipment can help smooth traffic flow.
- Advanced communications have improved the dissemination of information to the traveling public. Motorists are now able to receive relevant information on location specific traffic conditions in a number of ways, including dynamic message signs, highway advisory radio, interactive websites, targeted text alerts, in-vehicle signing, or specialized information transmitted only to a specific set of vehicles.
- Arterial management systems manage traffic along arterial roadways, employing traffic detectors, traffic signals, and various means of communicating information to travelers.

The largest ITS application in the 5-County area is the Kansas City Scout freeway-management system led by the Kansas and Missouri departments of transportation. The Scout system manages traffic on more than 100 miles of freeways in the Kansas City metropolitan area. Scout provides real time information to dynamic message signs, and cameras showing traffic conditions provided through the internet.

ITS Technology currently available is an effective tool to manage congestion by providing information about alternate routes and encouraging travel outside of the highest peak travel times. ITS Technology can lead to some improvement in travel speeds along freeway corridors and with signal coordination applications, improvements in travel speed along arterial corridors. Current ITS technology may not have a major impact on travel safety. Costs will vary with specific applications, but are generally less than with capacity projects. There are few issues which would impact implementation.

Traffic Incident Management

Traffic incident management is a planned and coordinated process to detect, respond to, and remove traffic incidents and restore traffic capacity as safely and quickly as possible. This strategy minimizes disruptions to existing capacity resulting from traffic incidents. Traffic incidents cause approximately 25 percent of traffic congestion.³ This strategy addresses non-reoccurring traffic congestion related to incidents which can occur anywhere on the transportation system. This strategy is considered to be supportive to any set of transportation investments that would be undertaken.

Traffic incident management can improve travel mobility in congested locations by reducing the severity and duration resulting from an incident on a freeway or highway. It also can improve travel safety. The strategy would require coordination with ITS infrastructure. By reducing the duration of congestion resulting from incidents, traffic incident management reduces vehicle emissions. This strategy is oriented toward highways, and as such will not impact travel choices.

Travel Information

This strategy involves providing information to users of the transportation system about congestion or other problems on their typical route to enable them the option to modify the trip.

In the Kansas City metropolitan area, the Kansas City Scout program provides real-time traffic webpages that provide up-to-the-minute information on traffic conditions such as speeds,

³ FHWA

congestion levels, real-time video images of roads, incidents, and other pertinent information. In addition, there are private companies such as Google that provide mapping of travel speeds. Some in-vehicle GPS navigation systems provide route information based upon traffic conditions. Travel information technology is also available for transit service in some areas.

An increasing number of transportation agencies are offering alerts to their customers on a subscription basis. Commuters can select specific routes for which they want to receive e-mail or text message alerts sent to a PDA, mobile phone, or an Internet account. KDOT provides e-mail alerts on traffic conditions, construction projects, or weather information to subscribers and those connected by Twitter. Transit agencies can provide e-mail alerts on a commuter's specific routes sent to a PDA, mobile phone, or to an Internet account. KDOT is currently working to aggregate traveler information into one portal called KanDrive.

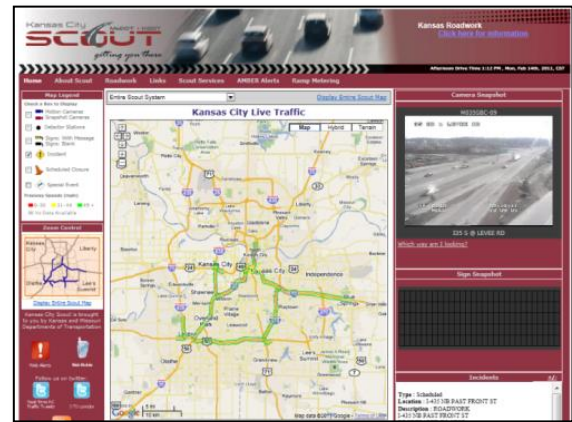


Figure 5. Kansas City Scout Website

The KanDrive website is <http://www.kandrive.org/> and is also the web location for Kansas 511. Emails and tweets are sent out for geographically relevant projects. The Kansas City Area Transportation Authority (KCATA) has a program called Web Watch, which enables users to receive emails or view from the website (http://www.kcata.org/maps_schedules/webwatch/ie) the real-time location of transit vehicles on specific routes. Technology is available to provide information to transit users on the vehicle location and arrival times at stops directly to mobile phones or to web sites. Studies have determined that providing access to real-time information on transit vehicle arrival time reduces transit user's perceived waiting time by 20%⁴. Passenger information at transit stops is estimated to be 7% of BRT's elasticity increment⁵ for attracting new riders.

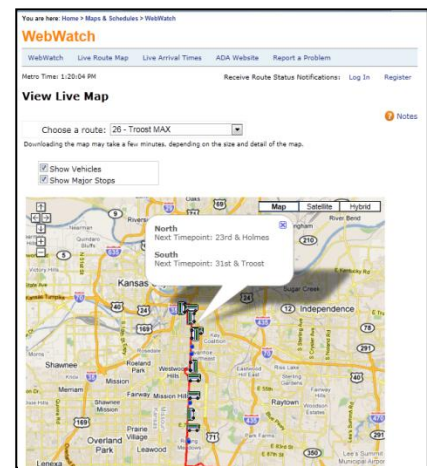


Figure 6. KCATA WebWatch
Source: KCATA

Providing travel information is a valuable service to transit users and the motoring public allowing individuals to better manage travel. In aggregate, the impacts of this strategy related to the reduction of congestion, increase in travel speed, or changes to VMT are difficult to measure. This strategy does provide information that can support making travel choices.

⁴ Dziekan, K., Vermeulen, A. 2006. *Psychological Effects of and Design Preferences for Real-Time Information Displays*. Journal of Public Transportation, 9(1): 71-89

⁵ Transportation Research Board. (2007). *TCRP Report 118, Bus Rapid Transit Practitioner's Guide*: 3-23

Investments in the technology needed to provide the information does result in moderate costs, but are well received by the public.

Parking Management

Parking management strategies include minimizing parking requirements and providing information about parking availability. Allowing coordinated parking between complementary daytime/nighttime or weekday/weekend land uses potentially reduces the number of spaces necessary for a development. Displaying real-time information of available parking spaces reduces the amount of both vehicle dwell in parking lots and circulation in the surrounding street network. Parking management can also include the use of regulation and fees; parking facility operation and maintenance; special event transportation and parking distribution plans. Parking management has been used to compliment other travel demand strategies.

The following are examples of parking management:

- Fees for Parking where a high cost results in lower single occupancy vehicle rates.
- Discounts for carpooling / ridesharing, when combined with preferential locations and ridesharing matching programs. This must be balanced to avoid shifting mode share from transit.
- Providing electronic signage to offer real time information about parking space availability.

Within the 5-County area, the largest example of parking management is at University of Kansas in Lawrence and the Medical Center in Kansas City. Both university locations use parking management where annual parking fees, restricted access, and limited supply provide incentives for alternative mode use and prevent the need to construct additional parking structures.

Parking management provides information regarding parking availability leading to a reduction in congestion at an activity center. With incentives, parking management can support a shift in travel mode. This strategy helps reduce congestion particularly related to event parking. This strategy can lead to small reductions in VMT. Investments in the technology needed to provide the information does result in some costs, but much less costly than constructing new parking facilities.

B. Travel Demand

These types of strategies address transportation needs by reducing the number of trips taken during peak travel periods. This set of toolbox strategies have a lesser impact on mobility and

traffic safety, but instead address the “desired outcome” to provide travel options, particularly for persons without access to private vehicles. These demand-side strategies are often referred to as Travel Demand Management (TDM). Many of the travel demand strategies contribute to supporting public health, regional prosperity, social equity and livability.

Ridesharing

Ridesharing includes both carpooling and vanpooling. A carpool is where two or more people share a ride in a private vehicle. Carpools generally have two or more passengers who live in the same neighborhood, or along the same route, using a private vehicle to travel to common or nearby destinations. A vanpool is where a larger group of people share a ride in a prearranged vehicle.

Mid-America Regional Council’s RideShare Program is an example of a program that offers assistance to individuals to match potential shared rides and information to employers about carpooling and vanpooling. Users enter their trip information into the RideShare website and are matched to other users with similar trip patterns. This service is orientated towards daily commuter trips. Increasing vehicle occupancy during peak commuter travel periods would have benefits in the reduction of congestion, reduction in VMT and improvements in air quality. The participation in carpooling and vanpooling has contributed to slowing traffic growth. This is a complementary strategy to addressing mobility needs within a given corridor.

A recent variation of ridesharing is called dynamic ridesharing. Also known as ad-hoc ridesharing or dynamic carpooling, dynamic ridesharing is a service that coordinates carpooling on very short notice. Private companies, such as Zimride, link ride matches and account creation to within existing networks such as universities, corporations, and social networking websites. Typical attributes for this type of carpooling include:

- One-time trips instead of reoccurring commutes.
- Utilizing mobile phones for placing and receiving carpooling requests.
- Utilizing either already existing social network or a service-specific network for automatic and instant ride matching.
- Driver compensation by the rideshare service through an integrated billing service.

Ridesharing provides a transportation choice for work travel. It is a strategy that can result in fewer vehicle trips taken during the peak hour. In aggregate, this strategy would only have small impacts to reduction of congestion, travel safety, or to the environment. It is not a costly strategy to provide. It is a strategy that addresses social equity in that it is a travel option provides access to jobs for persons without access to their own vehicle.

Public Transportation

The two primary types of public transportation service include fixed route and paratransit. Fixed route transit provides designated public transportation that is operated along a prescribed route according to a fixed schedule. Paratransit transit service does not follow fixed routes or schedules, and provides service to customers unable to access fixed route service. Paratransit service often entails providing on-demand door-to-door service from any origin to any destination in a service area.

Public transportation typically serves specific travel markets. One market is households considered transit dependent. Transit dependent households have limited access to private vehicles, are elderly, are persons with disabilities, or cannot afford the costs to operate a vehicle. Another travel segment served by public transportation is work trips, oriented toward major employment centers such as the Kansas City, Kansas and Missouri Central Business Districts or the University of Kansas.

Specific development characteristics are needed for fixed route transit service to be cost-effective. This includes having concentrations of residential development near a transit route with pedestrian connections to provide good access. Parking spaces need to be made available for park and ride access for persons located further away from a route. Access is also necessary at the destination end of the trip.

Transit service improvements would include:

- Provide additional revenues to support increased transit operations. This would include providing additional local transit route service, increasing frequency and service times to mid-day, evening and weekends.
- Increasing paratransit service, to provide for additional trips for persons with disabilities, and the elderly, as well as other potential users.
- Construction of transit amenities such as bus shelters, improving existing or constructing of new park and ride lots and providing real time information on bus arrival times.

Public transportation provides transportation to persons without access to private vehicles, and for some travel markets, can attract “choice” riders. In most cases, public transportation use does not have a large effect on traffic congestion levels and roadway safety. Increased transit service can lead to reductions in vehicle emissions. It is a strategy that addresses social equity in that it is a travel option provides access to jobs and other destinations for persons without their own vehicle. Transit projects are considered to support the development of a pedestrian environment considered important to improving livability.

Transit operating costs are typically large enough to be concern to local governments. Funds for daily operations are required from local or state sources and the lack of these funds have limited the growth of transit service. The costs of capital funding are more easily shared using federal sources.

Bicycle and Pedestrian Travel

Many of the bicycle and pedestrian considerations are contained within the concept known as “complete streets”. This policy approach includes a focus on the design and operation of an entire right-of-way to enable pedestrians, bicyclists, motorists, and transit riders of all ages and abilities to move safely along and across a street or highway.

The techniques used to create complete streets include sidewalks buffered from cars; reducing crosswalk crossing distance; bus pullouts or special bus lanes; traffic calming features, such as sidewalk bulb outs and on-street parking; and the use of bike lanes and bike parking areas. To encourage pedestrian use, complete streets have features that make users feel comfortable and safe (for example benches and other resting places, street art that adds interest, buildings that front the street with windows and doors, street lighting, clear directional signage, and narrow street widths).

A related approach is called Context Sensitive Solutions (CSS) which is a process that involves customizing road design to fit within its surrounding context. One primary example is transitioning a high-speed suburban road that enters a community, a neighborhood, or some other walkable district, into a more human-scaled design that causes cars to drive slower to support a walkable, pedestrian-friendly environment. A CSS process can apply to the planning of a new road, a road widening, or rehabilitation or retrofit of an existing road facility.

Bicycle accommodations can be considered when addressing transportation projects. Facility enhancements that separate bicycle and pedestrians from vehicle traffic increases safety. In some cases, bike lanes can be added to existing roadways through restriping. Other roadway improvements can be made to improve the visibility of the roadway use for bicyclists. Many communities are incorporating additional roadway width into their street standards to accommodate bicyclists. Some state departments of transportation provide bicycle facilities along highway corridors. In addition to creating additional facilities, projects that enhance bicycle safety, such as lighting, signage, striping and pavement quality are important to consider when accommodating bicyclists.

Providing for effective movement of pedestrians can be challenging in auto-oriented suburban environments. Numerous actions can be considered to create a safer environment for walking. Sidewalk safety projects can include installing curb cuts, curb extensions, median pedestrian

refuges, and crosswalks. In some cases bridges, interchanges or freeways result in barriers to pedestrian movement and can be addressed.

Bicycle and pedestrian improvement strategies address objectives related to transportation choice and public health. Bicycle and pedestrian improvement strategies can provide a small positive impact in the reduction of congestion, reduction in VMT and improvements in air quality. While these strategies may have little institutional barriers related to implementation, in some cases there are decisions related to trade-offs between bicycle accommodation and lower vehicle capacity or lower travel speeds. This strategy addresses the social equity objective to the extent that the specific projects are provided to all population sub-groups and also to the extent in which the strategy improves access to-and-from transit. The direct connection between bicycle and pedestrian projects and economic prosperity is generally considered to be longer term in that improvements in livability can attract or sustain growth.

Alternate Work Hours (Shift in Time of Trip)

This strategy, often called “flextime,” involves varying work schedules to shift work trip departure-times away from peak congestion times, rather than maintaining traditional arrangements requiring employees to work a standard 8:00 AM to 5:00 PM day. In a compressed work week, employees complete their required number of work hours in fewer-than-normal days per week (or per pay period) typically leading to commute travel that avoids the peak travel times. This arrangement allows employees to have one day off each week or one day off every other week, depending on which type of compressed work week program is utilized.

Promoting flextime supports a transportation choice for work travel related to the time of travel. In aggregate, this strategy helps reduce travel during the highest periods of travel. This strategy contributes to reducing of congestion, but has less impact on travel safety, or changes to VMT. Some improvement in air quality is possible with movement of travel to less congested times. It is not a costly strategy to provide. The strategy has very little impact on public health, regional prosperity and livability.

Telework

Teleworking defined is working full- or part-time at home or another off-site location. Teleworking is increasingly used by employers to reduce the demand for office space and parking. The use of electronics to communicate for various work activities is expanding and provides some benefit to trip reduction. While beneficial, this strategy is considered a complementary strategy with other strategies to address corridor needs.

Promoting telework supports a transportation choice for workers to avoid making the commute. If widely used, this strategy could potentially provide small reductions in peak period congestion and VMT, and provide small improvement in air quality. It is not a costly strategy to provide. Because the time previously spent travelling is now available for other uses, this strategy can have a positive impact on public health and livability.

Land Use Management

The type, intensity and site planning associated with land development can influence transportation conditions. These are regulatory strategies involving changes in land use plans, zoning codes, subdivision ordinances and other development policies which can be used to collectively guide development in a way to lessen traffic impacts and provide a greater balance between travel modes.

One land use management strategy involves developing site plans that result in livable, walkable, and healthy places to live. Conventional development patterns often create a low density development pattern where nearly all travel must be completed using private automobiles. Instead site planning can promote a development pattern where buildings are located in a way that can be accessed by walking or biking. Development can also be located close to public transportation to enable more potential riders to use transit. Many of these land development principles are described as Transit Oriented Development (TOD) or neo-traditional land use.

A second land use management strategy involves ensuring that the trip generation of planned activity centers can be supported by the existing roadway system. If a higher level of activity were to be proposed, improvements to the existing transportation system would need to be made in order to maintain the desired level-of-service.

A third land use management strategy is oriented to the regional level. This strategy involves using the local planning process to ensure that affordable housing is provided nearby to employment centers. In some high employment areas, affordable housing may not be available, which can result in longer commutes. Conversely, higher end residential areas may be located away from the central city, which can result in longer commutes for that income group.

Land use management strategies are typically applied at a site or corridor level. Land use management at the site level can result in lower traffic congestion on the arterial adjacent to the site development. If implemented on a corridor scale, these strategies could have larger impacts on transportation system performance, mode choice and urban form leading to a reduction in VMT. This strategy directly addresses livability and public health by encouraging pedestrian and bicycle travel. Land use management can also lead to shorter trip lengths,

lower travel speeds and improved travel safety. The cost of these strategies is low for the public agencies but could result in added infrastructure costs to site development.

C. Increasing Capacity

Increasing capacity refers to traditional transportation supply strategies such as adding travel lanes, modifying interchanges to accommodate higher traffic volumes and constructing new highways or urban arterials. It can also involve major capacity increases for public transportation. Capacity projects are often identified for roadway locations where the level of traffic volume results in traffic congestion. When this occurs, a traffic study or a design project is often initiated to determine how to increase roadway capacity.

Projects to increase roadway capacity are typically undertaken to address existing or anticipated traffic congestion or to provide a new route connection. In order to complete the project, sufficient right-of-way needs to be available and the project should not result in adverse environmental impacts. Projects of this type are targeted to provide benefits to the overall driving public. This includes a majority of the population but does not include those without access to a vehicle, or people who use non-auto modes.

Potential or planned transportation capacity projects are identified in the Long Range Transportation Plans prepared by the two Metropolitan Planning Organizations located in the 5-County region. Projects which have a dedicated funding source and are scheduled over the next five years are listed in each MPO's Transportation Improvement Program. In addition, KDOT has developed a transportation program called T-WORKS which identifies funding for transportation capacity projects through 2020. These sources provide a listing of planned capacity projects for the 5-County region.

While capacity projects typically address traffic congestion in the short term, adding capacity can support a long term cycle of congestion. This occurs when the added capacity induces new demand, which causes congestion to return. Other long term impacts of focusing resources on roadway capacity solutions include enabling growth to occur outward resulting in lower overall densities and disinvestment in older more established areas.

Add Travel Lanes

This includes projects to widen existing highways and arterial streets by adding through travel lanes. These projects are typically targeted to congested locations and provide a direct impact of reducing traffic congestion and travel time by adding vehicle capacity. Often roadways are widened in new or recently developed areas in response to higher traffic that is now generated for that development. In some cases, roadways in developed areas are widened in response to

increased traffic traveling through the area. Acquiring the right-of-way for these projects can be difficult, and the project can impact adjacent development.

Adding travel lanes directly addresses the objective of improving vehicle mobility and as a strategy that will potentially lead to an increase in regional prosperity. Lane addition projects can be difficult to implement, particularly where there are impacts to right-of-way, community and the environment. The projects typically involve a relatively high project cost.

Some lane addition projects have secondary impacts. Larger lane addition projects that reduce vehicle travel times increase accessibility outward and can lead to economic development at the edges of the urban area. An expanding metropolitan area can result in longer trip length which over time leads to a return of traffic congestion. The resulting higher vehicle miles of travel can also lead to higher vehicle emissions. There are cases where lane addition projects can bring air quality benefits if the project provides a reduction in stop-and-go congestion. The impact on public health will be minimal or possibly negative if the project leads to higher vehicle emissions. Another unintended consequence of roadway widening is that by adding width and carrying more traffic, the projects make pedestrian and bicycle travel more difficult. Adding travel lanes typically does not impact travel safety as the design characteristics of the roadway should not change.

Modify or Add Interchanges

This includes adding capacity to existing interchanges by modifying the ramp configuration, widening ramps, or adding collector/distributor roads. It also includes building new interchanges on existing freeways. The purpose of interchange projects is to provide access to land adjacent to freeways. The exception is with system-to system interchanges where the primary objective is to improve mobility on the freeway system. This type of project could lead to an increase in VMT and little impact on travel speeds. Major system interchange reconstruction projects can cost upwards of \$400 million or more. Access interchange construction or reconstruction is less costly, typically between \$5-15 million. These projects require a break-in-access study to be completed for Federal Highway Administration (FHWA), and can involve environmental impact studies.

Often improved access leads to an increase in economic activity of the area served, which should improve regional prosperity. The projects typically involve a relatively high project cost. Interchange projects typically have fewer implementation concerns that do roadway widening projects. In general, improving an existing interchange should not lead to higher vehicle miles of travel and higher vehicle emissions with the exception with new interchanges located on the edge of urban areas which could lead to higher VMT and emissions. The impact on public health will be minimal. Larger interchange projects may have a long term negative impact on livability. By adding width and carrying more traffic, the projects can make pedestrian and

bicycle travel more difficult unless these modes are accommodated in the project design. Often interchange modifications can lead to improved travel safety if the design characteristics of the roadway are upgraded.

Construct New Highways or Arterials

This strategy involves constructing new roadways on new alignments. In recent years, issues related to implementation such as right-of-way acquisition, project cost and environmental impacts have limited the construction of highways or arterials on new alignments.

Constructing new highways or arterials addresses the objective to improve or maintain mobility. Often a new roadway will provide a more direct connection between points, or relieve an existing route which may be congested. This strategy also provides the means to develop additional land area. New highway or arterial projects can be very difficult to implement due to right-of-way impacts, impacts to the community and to the environment. The projects typically involve a high project cost.

This strategy can address the objective of regional prosperity but it may also involve consideration of other transportation objectives. If a new alignment is located on the periphery of the urban area, it may lead to an expanded urban area and higher vehicle miles of travel. The impact on public health will be minimal or possibly negative if the project leads to higher vehicle emissions. If attention is given to accommodating bicycles and pedestrians, those impacts can be minimal. New road construction would positively impact travel safety as the design characteristics of the new roadway would likely be higher than current facilities.

Intersection Capacity Projects

This strategy involves adding turn lanes or constructing round-about intersections. Often the capacity and traffic flow related to an arterial route is dictated by the operation of its intersections. The primary objective of an intersection capacity project is to improve travel times by reducing vehicle delay at an intersection. Often this project could involve adding left or right turn lanes.

Intersection capacity projects contribute to the improvement of intersection operation, but will also increase pedestrian crossing distances which can negatively impact the pedestrian environment. Intersection projects often improve vehicle safety by removing turning vehicles from through traffic lanes. The reduction in vehicle delay reduces vehicle emissions. Impacts to public health may be less clear -- the reduced vehicle emissions provide a benefit, but the negative impact on the pedestrian environment is a negative impact. Intersection capacity projects may provide small economic benefit due to improved access but this is difficult to

measure on a regional scale. The costs related to this type of project can be relatively low, particularly if right-of-way is available.

Transit Capacity

A number of activities are underway to improve transit service in order to attract new riders and improve the experience for existing riders. These include construction of transit amenities such as bus shelters, improving existing or constructing new park and ride lots and providing real time information on bus arrival times. Service improvements are also being planned to increase service frequency and reduce the transit travel times.

For the Kansas City metropolitan area, MARC has defined locations for potential higher capacity transit service along urban corridors and freeway corridors. A number of these higher capacity corridors are currently in operation. In Kansas, this includes the K-10 Connector route that is operated by Johnson County Transit and provides a connection between higher education campuses in Johnson and Douglas Counties. Design work is being completed to enhance transit service along two additional corridors, including State Avenue in Wyandotte County and along Metcalf Avenue, Martway Street, and Shawnee Mission Parkway in Johnson County. An example of express bus that operates in Johnson County is shown in Figure 13.

The following lists options under consideration in the 5-County area that provide an increasing level of transit capacity and service characteristics:

Enhanced Transit involves providing a bus route that can include features such as additional passenger amenities at transit stops, improved transit stations or bus shelters, improved park-and-ride lots, real time schedule displays, and Transit Signal Priority (TSP) strategies to modify traffic signals with extended green time to optimize and reduce transit travel time and improve transit system reliability.

Bus Rapid Transit (BRT) provided in mixed traffic lanes combines station/shelter enhancement, unique vehicles, increased service frequency, and Intelligent Transportation Systems (ITS) elements. BRT systems can be described in two categories – BRT systems with dedicated guideways and BRT systems that operate predominately on regular travel lanes in mixed traffic. In some instances, the mixed traffic travel lanes are restricted for BRT use only for certain portions of the day. BRT features can include exclusive ITS treatments, simplified fare payment methods, specially branded vehicles, and passenger stations with increased amenities. BRT also involves Transit Signal Priority (TSP) strategies to modify traffic signals with extended green time to optimize and reduce transit travel time and improve transit system reliability.

Guideways can be constructed to provide exclusive transit right-of-way. It may include track improvements for commuter rail or exclusive transit lanes to operate BRT service. In more urban environments with high transit ridership, light rail transit, commuter rail or streetcar lines have been constructed.

Bus on Shoulder is oriented toward serving longer distance transit trips where buses could by-pass freeway congestion by using the travel shoulder.

Increasing transit capacity is a strategy targeted to improving transportation choice. It is targeted to attracting “choice” riders by improving the performance and convenience of transit. This strategy leads to a reduction in VMT, fewer vehicle emissions and in the long term could support a compact land use pattern consistent with public health objectives. However, with a lower density development pattern, it becomes increasing difficult to serve diverse trip origins and destinations with a single route. Transit capacity projects involve capital costs and increases in annual operating costs required with added transit service. Transit capacity projects impacting right-of-way would have the same public concerns as with roadway widening.



Figure 7. K-10 Connector at KU Edwards Campus
Source: Olsson Associates

High-Occupancy Vehicle (HOV) and Managed Lanes

HOV lanes are exclusive roadways or lanes designated for high-occupancy vehicles, such as buses, vanpools, and carpools. New HOV lanes can be constructed or an existing lane can be converted for HOV use. A new lane would be a capacity project, while conversion would be a management strategy.

The facilities may operate as HOV lanes full time or only during the peak periods. HOV lanes typically require minimum vehicle occupancy of two or more persons. However, in some locations, occupancy requirements have been increased to prevent congestion on the HOV lane. Support facilities, such as park and ride lots

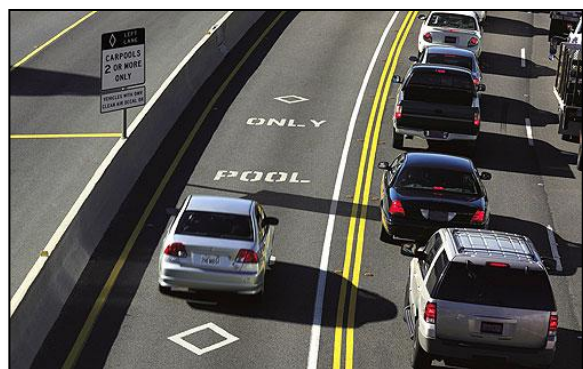


Figure 8. Example of HOV Lanes
Source: Metropolitan Washington Council of Governments

and transit centers with direct access to the HOV lane, are important system elements to increase facility use. HOV lanes may also be used to provide bypass lanes on entrance ramps with ramp meter signals.

High Occupancy Vehicle (HOV) facilities serve to increase the total number of people moved through a congested corridor by offering two kinds of travel incentives: a savings in travel time, along with a reliable and predictable travel time. Because HOV lanes carry vehicles with a higher number of occupants, they can potentially move more people during congested periods, even if the number of vehicles that use the HOV lane is lower than the adjoining general purpose lanes. In general, carpoolers, vanpoolers, and bus patrons are the primary beneficiaries of HOV lanes by allowing them to move through congestion. Keys to the success of lanes include location (areas of high congestion do better); enforcement; interagency coordination; synergy with parking policy, trip reduction ordinances, transit, ridesharing programs, education and marketing.

Managed Lanes are a set of lanes where operational strategies respond to changing conditions such as congestion levels, travel speeds, or downstream incidents. Managed lanes often combine tolling and vehicle occupancy elements. High-occupancy toll lanes, or HOT lanes, allow single-occupant vehicles to utilize HOV lanes for a fee. HOT lanes can expand the range of travel choices available to all users and even help articulate the perceived “value” of HOV lanes to transit, vanpool, or carpool travelers able to use the same lanes at free or reduced rates. Revenues generated through fees paid by single-occupant vehicles on HOT lanes can be used for transit and ridesharing services along a HOT/HOV route.

HOV and Managed Lanes are strategies targeted to improving transportation choice. They are both strategies that encourage achieving transportation objectives beyond mobility. HOV lanes support attracting “choice” riders by improving the performance and convenience of transit or carpools. This strategy can lead to a reduction in VMT and fewer vehicle emissions. Managed lanes add a toll component, supporting project costs or providing a congestion pricing mechanism while still supporting transit objectives. However, these projects involve extensive capital costs particularly with new lane construction. HOV/Managed lane projects impacting right-of-way would have the same public concerns as with roadway widening.

Bicycle and Pedestrian Facilities

Bicycle and pedestrian facilities can include sidewalks, bicycle lanes, wider street accommodation for bicycles and trails. The type of projects or facilities includes:

- Stream or greenway trails
- Arterial street accommodations
- Transit access facilities

- Sidewalks, including safe routes to school

Both MARC and Lawrence-Douglas County MPO have prepared bicycle and pedestrian elements of their Long Range Transportation Plans. MARC has overseen the development of a project called MetroGreen which defines a system of greenway trails. In addition, many local governments have developed approaches to accommodate bicycles and provide for sidewalks or trails as part of development and as part of street construction and re-construction.

Bicycle and pedestrian facilities address the toolbox objectives of increasing transportation choice and support healthier lifestyles. The costs related to trail projects will range depending on right-of-way and utility constraints. Trail costs can vary between \$250,000 per mile to \$1 million per mile in complex locations. Sidewalk projects will also vary but typically range approximately \$100,000 per mile. The impact on traffic congestion and level of VMT is typically minimal. These projects do contribute to public safety.

Freight Rail Track Improvements

In some cases public funds are used for track related projects or grade separations that reduce rail-vehicle conflicts, in situations where improving the flow of freight also reduces trucking demand on highways or where the rail project results in economic development.

Freight rail improvements address transportation choice related to the movement of goods. The public support of rail projects in specific cases is done in order to reduce rail – vehicle conflicts or to have an influence on shifting goods movement from truck to rail. In this case, the strategy will provide mobility benefits and support regional prosperity. The rail grade separation project can be cost

Conclusions

The transportation toolbox provides the mechanism to evaluate how potential transportation strategies meet a wider set of transportation objectives. Specifically, transportation toolbox provides a way to be able to see how a wide range of possible transportation strategies can lead to achieving a greater number of the desired outcomes identified in the 5-County Study. To better achieve these desired outcomes, a number of toolbox strategies will need to be combined. For example, many of the strategies that reduce transportation demand could be implemented together to achieve a stronger impact. In other cases the time frame in which strategies produce benefits may also vary. For example, land use management could be implemented along a newly developing corridor. The benefits of this approach may be incrementally achieved over a period of years rather than immediately observed.

The toolbox process also highlights how focusing on one type of strategy may not achieve all of the desired outcomes. The toolbox highlights how some strategies may be more effective at addressing congestion but may not address other desired outcomes, not serve all travel markets or be costly or difficult to implement.